Sintec Optronics

Nd:YAG Rods

Capabilities:

- Rod size: 2 - 12mm in diameter and 1 - 180mm in length;
- Nd dopant concentration : 0.6% - 1.3%;
- Polishing;
- AR-coating or/and dichroic coating;

Nd:YAG Crystal

During the last decade, Nd:YVO4 has been developed as a promising substitutes for Nd:YAG in diode-pumped lasers due to its high absorption and emission cross-sections. However, the applications of Nd:YVO4 are limited due to its poor physical-mechanical properties and growth difficulty etc. Now, we have developed the high-doped Nd:YAG (SUPER-Nd:YAG) recently. It shows high absorption cross-section and have many advantages over Nd:YVO4:

- Due to the cubic symmetry and high quality, Nd:YAG is easy to operate with TEM_{oo} mode
- Nd:YAG can be Q-switched with Cr4+:YAG directly
- Nd:YAG can produce blue laser with the frequency-doubling of 946nm
- Nd:YAG can be operated in a very high power laser up to kW level

The high neodymium-ion doped YAG has been grown by the novel technique-Temperature Gradient Technique(TGT). The Nd concentration can be doped up to 3%. As large as ϕ100x80mm bulk crystals with excellent optical homogeneity, less scattering particles, low dislocation density have been obtained.

Basic Properties:

Chemical Formula:	$Y_3Al_5O_{12}$
Crystal structure:	Cubic
Lattice constant:	12.01Angstrom
Melting point:	1970° C
Density:	4.5g/cm^3
Reflective Index:	1.82
Thermal Expansion Coefficient:	7.8x10^{-6} /K <111>
Thermal Conductivity (W/m/K):	14W/m/K, 20° C 10.5W/m/K, 100° C
Mohs hardness:	8.5
Stimulated Emission Cross Section:	2.8x10^{-19} cm^{-2}
Relaxation Time of Terminal Lasing Level:	30 ns
Radiative Lifetime:	550 μs
Spontaneous Fluorescence:	230 μs
Linewidth:	0.6 nm
Loss Coefficient:	0.003 cm^{-1} @ 1064nm

Laser Properties:

- SUPER-Nd:YAG shows high absorption coefficients at pumping wavelengths. Therefore, a crystal short-in length (e.g.1mm) is preferred and compact microchip lasers can be constructed by using SUPER-Nd:YAG.
- Due to the broader and smoothly-varied bandwidth of absorption, it allows of less stringent requirements of temperature control.
- Almost same output have been achieved both in a (111)-cut 1mm long Nd:YAG and an a-cut 1mm long YVO4 microchip lasers with a very short (9mm) laser cavity.

Spectra properties with concentration:

Nd:Dopant	2.5%	2%	1.5%	1.3%	1.1%	1%

Fluorescence lifetime	160µs	180µs	200µs	210µs	220µs	240µs
Absorption coefficient	7.55cm^{-1}	6.57 cm^{-1}	5.36 cm^{-1}	4.66 cm^{-1}	3.88 cm^{-1}	3.55 cm^{-1}

Optical Quality/Grades/Nd Level									
Rod Size		Standard Grade		Premium Grade		Standard [Nd]: 1.1 Atom%		Low [Nd]: 0.8 Atom%	
L	D	Extinct. Ratio	Wave Error	Extinct. Ratio	Wave Error	Tolerance of [Nd] Over Rod Length		Tolerance of [Nd] Over Rod Length	
mm	mm	(dB)	(waves)	(dB)	(waves)	Average [Nd]	delta [Nd]	Average [Nd]	delta [Nd]
50	3	>25	<0.19	>30	<0.13	±.08	0.06	±.07	0.05
50	4		<0.21		<0.15				
50	5		<0.24		<0.16				
100	4	>22	<0.28	>27	<0.18	±.08	0.13	±.06	0.09
100	5		<0.32		<0.21				
100	6		<0.36		<0.23				
100	6.35		<0.37		<0.24				
150	6.35	>20	<0.48	>25	<0.30	±.05	0.18	±.04	0.13
150	8		<0.58		<0.35				
150	9.52		<0.67		<0.40				
200	8	>19	<0.71	>24	<0.42	±.02	0.23	±.02	0.17
200	9.53		<0.82		<0.49				
200	10		<0.86		<0.51				

Coatings			
Type	Reflectivity (%R per Surface)	Damage Threshold (<20nS Pulse, GW/cm^2)	Damage Threshold (CW, kW/cm^2)
AR @1064nm	<0.15	>1.4	>25
HR @1064nm	>99.9	>1.0	>25

Nd:YVO4 Crystal

Nd:YVO4 is the most efficient laser crystal for diode-pumped solid-state lasers. Its good physical, optical and mechanical properties make Nd:YVO4 an excellent crystal for high power, stable and cost-effective diode-pumped solid-state lasers. Compared with Nd:YAG for diode laser pumping, Nd:YVO4 lasers possess:

- Lower lasing threshold and higher slope efficiency
- Large stimulated emission cross-section at lasing wavelength
- High absorption over a wide pumping wavelength bandwidth
- Low dependency on pumping wavelength and tend to single mode output
- Optically uniaxial and large birefringence emit strongly-polarized laser

We provide high quality and large size Nd:YVO4 and pure YVO4 crystal as large as ϕ35x50mm^3 bulk crystal and ϕ20x20mm^3 finished crystal at a very competitive price.

Basic Properties:

Atomic Density:	1.26x10^{20} atoms/cm^3 (Nd 1.0%)
Crystal Structure:	Zircon Tetragonal, space group D_{4h}-I4/amd a=b=7.1193 Angstrom, c=6.2892 Angstrom
Density:	4.22g/cm^3
Mohs Hardness:	4-5 (Glass-like)
Thermal Expansion Coefficient (300K):	a_a=4.43x10^{-6}/K; a_c=11.37x10^{-6}/K
Thermal Conductivity Coefficient (300K):	//C: 0.0523W/cm/K; $\perp$ C: 0.0510W/cm/K

Optical Properties:

Lasing wavelength:	1064nm, 1342nm
Thermal optical coefficient (300K):	dn_o/dT=8.5x10^{-6}/K, dn_e/dT=2.9x10^{-6}/K
Stimulated emission cross-section:	25x10^{-19}cm^2 @1064nm
Fluorescent lifetime:	90μs
Absorption coefficient:	31.4cm^{-1} @810nm
Intrinsic loss:	0.02cm^{-1} @1064nm
Gain bandwidth:	0.96nm @1064nm
Polarized laser emission:	π polarization; parallel to optic axis(c-axis)
Diode pumped optical to optical efficiency:	>60%

Laser Properties:

The Nd:YVO4 crystal has large stimulated emission cross-sections at both 1064nm and 1342nm. The stimulated emission cross-section of an a-axis cut Nd:YVO4 crystal at 1064nm is about 4 times higher than that of the Nd:YAG crystal. Although the lifetime of Nd:YVO4 is about 2.7 times shorter than that of Nd:YAG. Because of its high pump quantum efficiency, the slope efficiency of Nd:YVO4 can be very high if the laser cavity is properly designed.

Nd:YVO4 Specifications:

Transmitting wavefront distortion	less than λ/4 @ 633 nm
Dimension tolerance	(W ± 0.1 mm) x (H ± 0.1 mm) x (L + 0.2 mm/-0.1)
Clear aperture	>90% central area
Flatness	λ/8@633nm, & λ/4@633nm for thickness less than 2mm
Scratch/Dig code	10/5 to MIL-O-13830A
Parallelism	better than 20 arc seconds
Perpendicularity	5 arc minutes
Angle tolerance	< ± 0.5°
AR coating	R<0.2% at 1064nm, HR coating R>99.8% at 1064nm, T>95% at 808nm
Quality warranty period	one year under proper use.

Er:YAG

Erbium doped Yttrium Aluminum Garnet (Er:$Y_3Al_5O_{12}$ or Er:YAG) combine various output wavelength with the superior thermal and optical properties of YAG. It is an excellent laser crystal which lasers at 2.94μm. This wavelength is the most readily absorbed into water and hydroxylapatite of all existing wavelengths and is considered a highly surface cutting laser. It is a well known material for medical applications.

Material Properties of Er:YAG crystal

Chemical formula	$Er^{3+}:Y_3Al_5O_{12}$
Crystal structure	cubic
Melting point:	1970 °C
Density, g/cm^3	5,35
Mohs hardness	8.5
Thermal expansion coefficient	9,5 x 10-6 K-1 (a axis) 4,3 x 10-6 K-1 (b axis) 10,8 x 10-6 K-1 (c axis)
Thermal conductivity at 25°C	0.12 W x cm^{-1} x °K^{-1}
Loss coefficient at 1064 nm	0.003 cm^{-1}

Laser Properties

Laser Transition	$^4I_{11/2}$ to $^4I_{13/2}$
Laser Wavelength	2940nm
Fluorescence Lifetime	90 m s
Photon Energy	6.75×10^{-20}J(@2940nm)
Emission Cross Section	3×10^{-20}cm^2
Index of Refraction	1.79 @2940nm
Pump Bands	600~800 nm

Standard specifications

Dopant concentration, at.%	Up to 50
Orientation:	<111>within 5°
Flatness	< λ/10 measured at 633 nm
Parallelism	≤ 30"
Perpendicularity	≤ 5 ′
Surface Quality	10-5 per scratch-dig MIL-O-13830A
Optical Quality:	Interference fringes ≤ 0.125 λ /inch(@1064nm)
Extinction ration	≥ 25dB
Size:	Rods:Φ (3-10)mm ×(30-180)mm
Slabs:	(3-12)mm ×(6-24)mm ×(60-180)mm
Dimensional tolerances	Diameter:+0.000"/-0.05", Length: ± 0.05" Chamfer: 0.07+0.005/-0.00" at 45°
AR Coating Reflectivity	≤ 0.2% (@2940nm)

(Nd, Ce):YAG

Nd:Ce:YAG is an excellent laser material used for no-water cooling and miniature laser systems. the (Nd,Ce): YAG laser rod we produce has the characteristics of high efficiency(laser efficiency than Nd: YAG high about 30-50%), low threshold, anti-violet radiation and high repetition frequency for lasers operation. It has achieved the international advanced level .it is the most ideal laser material for the high repetition air cooling lasers. It suitable for different modes of operation (cw, pulsed , Q-switched, mode locked, doubling of frequency) and high-average power lasers

Physical and Chemical Properties

Chemical formula	$Nd^{3+}:Ce^{3+}:Y_3Al_5O_{12}$
Crystal Structure	Cubic
Lattice Parameters	12.01A
Melting Point	1970 ℃
Moh Hardness	8.5
Density	$4.56\pm0.04 g/cm^3$
Specific Heat (0-20)	$0.59J/g.cm^3$
Modulus of Elasticity	310GPa
Young's Modulus	$3.17\times104Kg/mm^2$
Poisson Ratio	0.3(est.)
Tensile Strength	0.13~0.26GPa
Thermal Expansion Coefficient	[100]:8.2×10^{-6}/ ℃ [110]:7.7×10^{-6}/ ℃ [111]:7.8×10^{-6}/ ℃
Thermal Conductivity	14W/m/K(@25 ℃)
Thermal Optical Coefficient (dn/dT)	7.3×10^{-6}/ ℃
Thermal Shock Resistance	790W/m

Laser Properties

Laser Transition	$^4F_{3/2}$ --> $^4I_{11/2}$
Laser Wavelength	1.064μm
Photon Energy	1.86×10^{-19}J@1.064μm
Emission Linewidth	4.5A @1.064μm
Emission Cross Section	$2.7\sim8.8\times10^{-19}cm^{-2}$
Fluorescence Lifetime	230μs
Index of Refraction	1.8197@1064nm

Standard Specifications

Dopant concentration, at.%	0.1-2.5%
orientation:	<111>within 5°
Flatness	< λ/10
Parallelism	≤ 10"
Perpendicularity	≤ 5 ′
Surface quality	10-5 per scratch-dig MIL-O-13830A
Optical Quality:	Interference fringes ≤ 0. 25λ /inch Extinction ration ≥ 30dB
Size:	Diameter:3～8mm; Length:40～80mm(Upon request of customer)
Dimensional tolerances	Diameter+0.000"/-0.05"; Length ±0.5"; Chamfer: 0.07+0.005/-0.00" at 45°
AR Coating Reflectivity	≤ 0.2% (@1064nm)

Yb:YAG - Ytterbium Doped Yttrium Aluminum Garnets

Ytterbium doped Yttrium Aluminum Garnet (Yb:$Y_3Al_5O_{12}$ or Yb:YAG) is one of the most promising laser-active materials and more suitable for diode-pumping than the traditional Nd-doped crystals. It can be pumped at 0.94 μm and generates 1.03 μm laser output. Compared with the commonly used Nd:YAG crystal, Yb:YAG crystal has a larger absorption bandwidth in order to reduce thermal management requirements for diode lasers, a longer upper-state lifetime, three to four times lower thermal loading per unit pump power. Yb:YAG crystal is expected to replace Nd:YAG crystal for high power diode-pumped lasers and other potential applications, such as, its doubling wavelength is 515 nm very close to that of Ar-ion laser (514 nm), which makes it possible to replace large volume Ar-ion laser.

Physical and Chemical Properties

Chemical formula	$Yb^{3+}:Y_3Al_5O_{12}$
Crystal structure	cubic
Lattice Parameters	12.01A
Melting Point	1970°C
Density, g/cm^3	4.56
Mohs hardness	8.5
Thermal expansion coefficient	7.8 x 10^{-6} x °K^{-1} , <111>, 0 - 250 °C 7.7×10^{-6}/°C, <110> (0~250°C) 8.2×10^{-6}/°C, <100> (0~250°C)
Thermal conductivity at 25°C	0.14 W x cm^{-1} x °K^{-1}
Loss coefficient at 1064 nm	0.003 cm^{-1}

Laser Properties

Laser Transition	$^2F_{5/2} \rightarrow {}^2F_{7/2}$
Laser Wavelength	1030nm
Photon Energy	1.93×10-19J(@1030nm)
Emission Linewidth	9nm
Emission Cross Section	2.0×10-20cm^2
Fluorescence Lifetime	1.2 ms

Spectral Properties

Diode Pump Band	940nm or 970nm
Thermal Optical Coefficient	7.3×10^{-6}/°C
Index of Refraction	1.82

Standard Specifications

Dopant concentration, at.%	0.5-30%
orientation:	<111>within 5°
Flatness	< λ/10
Parallelism	≤ 10"
Perpendicularity	≤ 5 ′
Surface Quality	10-5(MIL-O-13830A)
Optical Quality:	Interference fringes ≤ 0.125/inch, Extinction ration ≥ 30dB
Size:	Diameter:2~20mm,Length:5~150mm (Upon request of customer)
Dimensional tolerances	Diameter:+0.00"/-0.05"mm; Length: ± 0.02" ; Chamfer: 0.07+0.005/-0.00" at 45°
AR Coating Reflectivity	≤ 0.2% (@1030nm)

Nd:GGG

Nd:GGG is an optimal crystal for solid-state heat-capacity laser because of its high thermal diffusivity and large diameter resulting from its easiness of growth with flat interface between solid and melt. It is also a candidate for high average power laser with high pulse energy.

Advantages of Nd:GGG Crystals

- Suitable for high energy output at heat-capacity operation
- Large crystal diameter with good optical quality

Specifications

Dopant concentration	0.5~3at%
Orientation	[111] within± 5º
Wavefront distortion	≤ 0.5λ/inch@632.8nm(for the rod)
Extinction ratio	≥ 20dB @632.8nm(for the rod)
Sizes	Diameter 2~70mm, Length 3~100mm Upon request of customer
Dimensional tolerances	Diameter:+0.00"/-0.002", Length: ± 0.02"
Barrel finish	Ground Finish with 400# Grit or polished
Parallelism	≤ 10 arc seconds(for the rod)
Flatness	≤ λ/4@632.8nm(for the rod)
AR coating reflectivity	≤0.25% @1060nm

Optical and Spectral Properties of Nd:GGG Crystals

Laser transititon	$^4F_{3/2} \rightarrow {}^4I_{11/2}$
Laser wavelength	1060nm
Fluorescence lifetime	240μs
Index of refraction	1.94@1060nm
Diode pump band	808nm, 881nm

Physical and Chemical Properties

Crystal Structure	Cubic
Lattice Constant	12.383 Å
Moh Hardness	8
dn/dT	17 $x10^{-6}$/K
Poisson's Ratio	0.28
Melting Point	1725°C
Density	7.1 g/cm^3
Thermal Expansion	8 x 10^{-6}°C^{-1}

Cr^{4+}:YAG

$Cr^{4+}:Y_3Al_5O_{12}$ - Passive Q-switches or saturable absorbers provide high power laser pulses without electro-optic Q-switches, thereby reducing the package size and eliminating a high voltage power supply. Cr^{4+}:YAG is more robust than dyes or colour centres and is the material of choice for 1 um Nd lasers.

Physical and Chemical Properties

Formula	$Cr^{4+}:Y_3Al_5O_{12}$
Crystal structure	cubic
Mohs hardness	8.5
Melting point:	1970 °C
Density, g/cm^3	4.55
Thermal conductivity at 25°C	0.14 W x cm^{-1} x °K^{-1}
Thermal expansion coefficient	7.8 x 10^{-6}/°C <111> 8.2 x 10^{-6}/°C <100> 7.7×10^{-6}/°C <110>
Young's Modulus	3.17x10^{4}kg/mm^2
Thermal Shock Resistance	790 Wm^{-1}

Standard Specifications

Orientation:	<111>within 5° or <100>within 5°
Flatness	< λ/10
Parallelism	≤ 30"
Perpendicularity	≤ 5 ′
Surface quality	20-10(MIL-O-13830A))
Wavelength:	950 nm~ 1100nm
Initial transmittance:	5%~95%
Damage threshold	≥ 500MW/cm^2
AR coating reflectivity	≤ 0.2% (@1064nm)
Size	Diameter:3~ 20mm H × W:3 × 3~ 20 × 20mm
Dimensional tolerances	Diameter: ± 0.00/-0.05", Length: ± 0.05" Chamfer: 0.07+0.005/-0.00" at 45°